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MAP PRODUCTS FOR THE MODERN BATTLEFIELD(U) ARMY
ENGINEER TOPOGRAPHIC LABS FORT BELVOIR VA J E ALLEN
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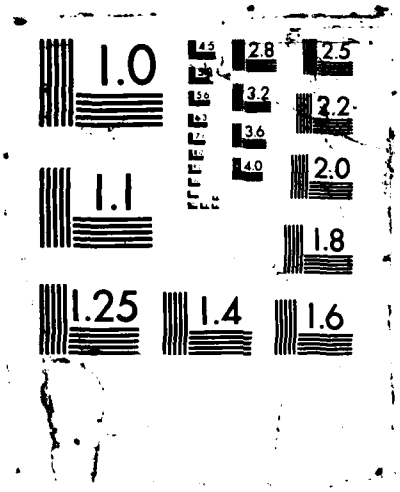
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The U.S. Army recognizes WEATHER and TERRAIN as the two most important factors effecting the outcome on the modern battlefield. The AirLand Battlefield Environment (ALBE) Demonstration and Evaluation Program, a joint effort involving the U.S. Army Corps of Engineers and the U.S. Army Materiel Command, is developing and demonstrating the software, sensors and methodology necessary to integrate a priori and near-real-time environmental data into map products. These map products, or Tactical Decision Aids (TDA), will provide the battlefield commander an increased capability to make tactical decisions and thereby defeat the enemy.

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AIRLAND BATTLEFIELD ENVIRONMENT (ALBE) DEMONSTRATION: MAP PRODUCTS FOR THE MODERN BATTLEFIELD

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ABSTRACT

The U.S. Army recognizes WEATHER and TERRAIN as the two most important factors effecting the outcome on the modern battlefield. The AirLand Battlefield Environment (ALBE) Demonstration and Evaluation Program, a joint effort involving the U.S. Army Corps of Engineers and the U.S. Army Materiel Command, is developing and demonstrating the software, sensors and methodology necessary to integrate a priori and near-real-time environmental data into map products. These map products, or Tactical Decision Aids (TDA), will provide the battlefield commander an increased capability to make tactical decisions and thereby defeat the enemy.

INTRODUCTION

Battlefield commanders have only limited access to environmental information during the battle planning process and virtually no access to such information during the battle. To effectively fight an enemy which may be superior in number, move rapidly in all types of weather, use smoke for concealment and use nuclear, biological or chemical weapons, a commander needs an increased capability to make tactical decisions. The manual methods used to acquire and analyze environmental data, and then to prepare Tactical Decision Aids (TDA) from these data is both time and labor intensive.

ALBE Tactical Decision Aids are digitally generated products that show commanders and their staffs the effects of terrain and environmental factors on both friendly and threat equipment, weapon systems and operations. Tactical Decision Aids do not make decisions themselves, rather they supplement the tactician's knowledge base and help him during the decision making process. Tactical Decision Aids are generated from the synergism of a priori digital elevation data,weapons systems performance data, force equipments data, structures data and near-real-time environmental sensor data. Tactical Decision Aids provide an invaluable tool in the formulation and execution of both pre-battle and during battle tactical decisions.

With the increase in the capabilities and the decrease in both the size and the cost of computer systems, the exploitation of the computer on the battlefield is here. Planned development and fielding of systems such as the Maneuver Control System (MCS), the All Source Analysis System (ASAS) and the Digital Topographic Support System (DTSS) will provide the battlefield commander the

capability to acquire, analyze and disseminate intelligence and environmental data in a timely manner.

To best exploit the capabilities of these new systems for maximum tactical advantage, the U.S. Army Corps of Engineers initiated the AirLand Battlefield Environment (ALBE) program. This program is a joint effort involving the Waterways Experiment Station (WES), the Cold Regions Research and Engineering Laboratory (CRREL), the Engineer Topographic Laboratories (ETL) and the Atmospheric Sciences Laboratory (ASL) of the U.S. Army Materiel Command (AMC).

Program strategy of the ALBE Demonstration Program is 1) assemble a hardware and software test-bed for use as the mechanism for demonstrating the generation of Tactical Decision Aids in a field environment, 2) refine Tactical Decision Aid software that has been developed as part of the Army's Tech Base program and install it on the test-bed, 3) develop surface and atmospheric sensors for the purpose of providing near-real-time data to the Tactical Decision Aid software, 4) in a series of exercises, demonstrate the integration of a priori and near-real-time environmental data to generate Tactical Decision Aids and 5) transition the Tactical Decision Aid software to Army field systems.

TEST-BED

The ALBE test-bed is composed of a weather- and a terrain-intensive portion. Both portions are mounted into separate Integrated Command Post shelters which are in turn mounted on the back of two Commercial Utility Cargo Vehicles (CUCV). The test-bed hardware is loaded inside the shelter during transport and can be removed and setup in a tent for a demonstration within two hours.

Hardware

Both the weather and the terrain portions of the ALBE test-bed are built around ruggedized MicroVax II Central Processing Units (CPU). The weather CPU is used primarily to collect, store and process surface and atmospheric sensor data, to store and process historical climatological data and to generate weather-intensive Tactical Decision Aids. The terrain CPU is used primarily to store and process elevation, force equipments and structural information data, to create, store and process terrain feature data, and to generate terrain-intensive Tactical Decision Aids. Because many terrain-intensive Tactical Decision Aids require surface and atmospheric data and many weather-intensive Tactical Decision Aids require terrain data, an Ethernet allows data to be transferred between the two CPUs. This configuration ensures maximum use of the hardware test-bed resources. If a large request for terrain Tactical Decision Aids is received, the weather CPU can take over some of the work, and vice versa. Both CPUs have nearly identical data storage devices. Each have three 380 Mb hard disk drives, one 95 Mb cartridge tape and one 44 Mb 9-Track Magnetic Tape. The weather CPU has one and the

terrain CPU has two 200 Mb 5 1/4" optical disks.
The terrain CPU has three and the weather CPU has two medium-resolution (640 X 480) graphics terminals. Both CPUs have one high-resolution (1024 X 1280) graphics processor. The medium-resolution terminals are the primary work stations and the high-resolution graphics processor is used to inspect the Tactical Decision Aid before production.
Output devices for graphics and text are identical on both CPUs. Each CPU has a Seiko Thermal Transfer color copier, an HP 7580B eight pen plotter (large format) and an HP 2934A Dot Matrix printer for text reports.
In addition, the terrain CPU is equipped with a digitizing table for digitizing hardcopy Tactical Terrain Analysis Data Base (TTADB) products provided by the Defense Mapping Agency (DMA) and a high resolution Charge Coupled Device (CCD) camera for generating background maps for the Tactical Decision Aids. The weather CPU has a suite of sensors to collect near-real-time environmental data. These data include temperature, wind speed and direction, barometric pressure, relative humidity, illumination, precipitation, atmospheric visibility and obscuration, and soil moisture and temperature.

Software

The Operating System for both MicroVax II's is MicroVMS, the command language is Digital Command Language (DCL), the assembly language is MACRO and the file editing software is VAX EDT text editor. All four are compatible with their counterparts found on the Digital main-frames such as the VAX 785.
Tactical Decision Aid software is written in several languages; however, most is written in VAX FORTRAN 77. Other languages used are VAX C and VAX PASCAL. A VAX ADA compiler will soon be installed and future software developments will probably be in ADA.
Graphics software for generating the products is written in GKS PVI GK - 2000.
The present Geographic Information System (GIS) is a carryover from work conducted earlier on the Terrain Analyst Work Station (TAWS). It is made up of several different programs - the Analytical Mapping System (AMS), the Map Overlay and Statistical System (MOSS) and the Map Analysis and Processing System (MAPS). AMS is used to digitize the DMA provided TTADB into vector format. TTADB comprises six hardcopy overlays - soils, slope, vegetation, obstacles, transportation and surface drainage. A program called Add AMS (ADWAMS) converts the digitized data into a format compatible with MOSS. MOSS then combines the six digitized overlays into a single data file and provides data to the Tactical Decision Aid software requiring vector data.
Finally, MAPS is data stored in raster format and is used by the Tactical Decision Aid software that requires raster data.

TACTICAL DECISION AID PRODUCTS

Under the ALBE Demonstration Program Tactical Decision Aids have been broken up into six categories:

Terrain and Atmospheric - Provides information dealing directly with the terrain and atmosphere and is used to support development of other products. Products include:

Intervisibility - This is a series of products generated from DMA Digital Terrain Elevation Data (DTED).
Line of Sight depicts a terrain profile between two points and graphically displays the line of sight between the two points.
Masked Area depicts those areas which can be seen/not seen from single or multiple sites.
Perspective View is a three-dimensional representation of the terrain that provides the user the ability to get a feel for the terrain in question.
Target Acquisition depicts the range at which an incoming target first becomes visible.
Weather Effects Messages - Textual information on weather effects messages warning of weather impact on friendly and threat systems and an Environmental Thresholds and Impacts planning report.
Surface and Upper Air Data - A three-dimensional depiction of the current state of the atmosphere including wind speed and direction, temperature, barometric pressure, etc.
Military Hydrology - Provides graphs and tables of water depths and widths, stream velocity and stream discharge over a specified period of time.
Target Area Winds - Provides an estimate of the terrain influenced and upper air winds in target areas.
Perspective View Shaded Relief - Depicts a three-dimensional shaded relief portrayal of a specified area of interest.
Climatic and Support Utilities - Text products that provide sunrise/sunset, moonrise/moonset and historical climatological data.

Ground Mobility - Provides mobility predictions for both cross country and on-road movement for various friendly and threat vehicles. Products include:

Off-Road Speed - Speed Map depicts speeds for single or multiple vehicles.
Terrain Factors Map depicts the factors which influence off-road mobility and reasons for speed reductions and restricted-go's.
Difference Map depicts speed differences between two vehicles.
Time Contour Map shows travel time in any direction from a single or multiple starting point.
Soil Moisture Map - A map of soil moisture conditions.
Travel in Shallow Snow - Depicts traction and motion resistance for wheeled or tracked vehicles over a specified area of interest.

On-Road Speed - Road Classification Map depicts roads and their classification (highway, secondary road, etc.).
Speed Map depicts on road speeds for specified vehicles.
Reasons Map depicts reasons for speed reductions and restricted-go's over a specified area.
Difference Map depicts speed differences over selected roads for two vehicles.
Time Contour Map depicts travel time from single or multiple starting points.
Bridge Influence Map shows the influence of bridge characteristics (width, load capacity, etc.) on vehicle speed.
Bridge Evaluation - Bridge Classification is a text of bridges and their characteristics for a specified area of interest.
Tactical Bridge Sites depicts location where drainage is suitable for bridging.
Gap Crossing - Gap Classification Map identifies natural streams and man-made linear features.
Gap Crossing Maps show go and restricted-go locations and speeds for specified vehicles.
Winter Bridging - Depicts potential winter river crossing sites.
Formation Movement - Troop Movement Overlay identifies road segments capable/incapable of formation movements.
Lines of Communication depicts the road network and describes bridges and road obstacles (slope, sharp curves, etc.) for a specified area.
Unit Movement Overlay depicts travel times for mechanized units.
Route Cover and Concealment - Cover and Concealment Map shows area of cover and concealment for a specified area of interest.
Route Selection Map depicts the best mobility route that maximizes cover and concealment and minimizes exposure time.
Road Usage - Provides predictions of the influence of road damage and repair on road usage for vehicle and convoy vehicle speeds, traffic volume and convoy movement times.

<u>Countermobility</u> - Provides information on predicted obstacle locations and the effectiveness of minefields. Products include:

Minefield Deployments - Various products which aid in the site and mine selection (Anti Tank and Anti Personnel) process and predict the effectiveness of minefields.
Frozen Soil/Snow Minefield - Depicts the effect of frozen soil and snow on a minefield.
Obstacle Deployments - Various products provide information concerning the environmental effects on the deployment and effectiveness of obstacles such as craters, wire, rubble, ditches, etc.
Obstacle Systems - provides predictions for time delay, movement restriction and resource requirements for emplacing obstacles.

Nuclear, Biological and Chemical - Provides information on the location, extent and persistence of NBC hazards and smoke, the side effects of chemical protective clothing and options for decontamination. Products include:

NBC Hazard - Generates NBC chemical and nuclear reports for identifying nuclear and chemical hazards, provides chemical downwind messages, generates recommended work/rest times and probability of heat stress casualties and identifies 'no fly' areas due to nuclear fallout and chemical hazards.

Smoke Generation - Text output identifying the optimal spacing and minimum number of generators needed to produce and maintain a large smoke screen needed to block both visible and infrared wavelengths.

Tube Delivered Smoke - Text output identifying the number of rounds, spacing, firing rate and targeting parameters necessary to maintain a smoke screen for a specified size and duration.

Chemical Decontamination - Text display outlining the types of equipment that need decontamination and a list of decontamination guidelines.

Weapon Systems Performance - Provides information on the effectiveness of electro-optical and seismic/acoustic sensors and systems, as well as top attack and other advanced munitions. Products include:

Electro-optical Systems - Provides the capability for predicting the performance of various types of electro-optical devices used for target acquisition.

Top Attack SCM Systems - Provides the ability to predict the effect of current and forecast environmental conditions on Self Contained Munitions (SCM).

Seismic/Acoustic Sensor Systems - Provides a near-real-time capability to detect, locate and classify threat vehicles using seismic and acoustic sensors.

Advanced Munitions - Provides the ability to predict the effectiveness of advanced munitions under current and forecast environmental conditions.

Army Aviation - Provides information on the conditions which affect aircraft performance, routes and altitudes. Products include:

Flight Weather - Identifies and depicts areas of probable aircraft icing, low-altitude high winds and wind shear, low-altitude turbulence and low-altitude precipitation.

Aircraft Vectoring - Paradrop Climatology provides information on probabilities of having favorable conditions for various types of paradrops.

Altimeter Setting computes the altimeter setting for aircraft.

Density Altitude/Helicopter Load computes density altitudes and load limits for helicopters.

Concealment depicts the probability of detecting a ground target from visual aerial surveillance.

Flight Line Masking displays areas shielded from view along

a flight path.
Air Avenues of Approach displays suitable paths for aircraft to reach a target while maintaining minimum detection from observers.
Helicopter Landing/Drop Zones depicts areas suitable for helicopter landings or paradrops.
Aircraft Performance - Provides the information (departure, cruise, climbing distance, etc.) necessary to complete the Performance Planning Cards, a prediction of the density altitude for a given time at a given site, and density altitude climatological data.

CUSTOMER TESTS AND FIELD EXERCISES

A series of demonstrations/tests has been setup whereby the Tactical Decision Aids will be tested and evaluated as to their accuracy, responsiveness and applicability to the needs of the commanders and their staffs, and the speed and ease of production versus that of manual methods. Three demonstrations have been scheduled so far - the first took place in December of 1987 at Ft. Lewis, Wash. during the Command Post Exercise (CPX) Cascade Peake IV, the second will be in the Spring of 1989 again at Ft. Lewis, Wash. during a CPX and the third will be in 1990 at Yakima, Wash. during a Field Training Exercise (FTX). Unfortunately, the ALBE Demonstration Program is piggybacked to the first two exercises and therefore the tests involve terrain data and environment data from different locations. The FTX scheduled in 1990 will be the first opportunity to realistically marry the terrain and environmental data.

CASCADE PEAK IV - CUSTOMER TEST

The first demonstration of the ALBE Tactical Decision Aids began with a training session 18 Nov - 5 Dec 1987 at the Battelle Pacific Northwest Laboratories in Richland, Wash. for the 537TH Engineers (Terrain); Detachment 6, 5TH Weather Squadron; and E Battery, 333RD Field Artillery. Instruction subjects included system software, digitizing, sensor placement and Tactical Decision Aid production.
Six test issues were established by the Combat Developments Experimentation Center (CDEC), the tester for the exercise. These issues were:

1) Can the ALBE test-bed receive and transfer near-real-time environmental and meteorological data in a field environment?
Nine Meteorological Sensor Packages (MSP), nine Present Weather System (PWS) and three Soil Moisture Sensors (SMS) were placed at various locations around Ft. Lewis. Every 15 minutes the sensors were queried for information. Thirty percent (30 percent) of the time all nine MSPs transmitted data, 19 percent of the time all nine PWSs transmitted data, and the SMSs rarely transmitted data - in fact one never

did.

2) Can the software modules of the ALBE test-bed combine environmental sensor data with digital terrain data to produce decision aids?

Over 160 product requests were made during the exercise and almost half required the integration of near-real-time environmental sensor data with topographic data. All products were successfully generated in hard copy and sent to the requestor.

3) Can the ALBE test-bed CCD camera acquire standard hard-copy products, such as maps, line drawings and overlays, in a field environment for use as backgrounds with TDA products?

A problem with the CCD camera resulted in only one background map being produced during the exercise. It took 48 minutes to produce this one product and the results were considered very satisfactory.

4) Can ALBE transfer completed TDAs to the Automated Distributed Intelligence System (ADIS)?

It was possible to transmit a completed product over the Ethernet to the ADIS. However problems with the color contrast of the background map made the received product unusable.

5) Can the ALBE test-bed generate TDAs which significantly benefit the commander's planning and execution process?

An overwhelming majority (89 percent) of the Tactical Decision Aid users were happy with the products, the speed of production and the benefit to their mission. Problems with the legends and especially the map scale were noted by a significant number of users.

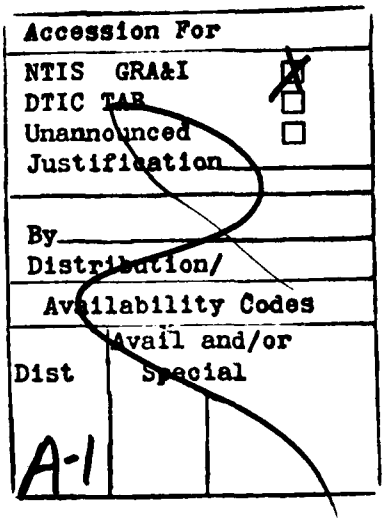
6) What are the MANPRINT characteristics (limited) associated with the use of the TDA software and the products of the ALBE test-bed?

Items noted for improvement included a better, more structured training session with time for trainee feedback, structural changes to the on screen menus, standardization of symbols and legends with only necessary information on a product, and some method for indicating the scale and orientation of the three dimensional products.

Successful is the best way to describe the first demonstration of the ALBE Tactical Decision Aids. Logistical and organizational kinks apparent in this exercise were expected considering the short time from the formulation of the program to this test. The need for software modifications, which are mostly at the user interface level, was also expected. Many changes to the user interface aspect of the software have been put off until a new GIS is installed in 1988. User feedback is a very important part of any demonstration program and the feedback from this first exercise will result in an even more successful demonstration in May of 1989.

SUMMARY

Improved capabilities for battlefield commanders is what this program is all about. Generating products in minutes instead of the hours it now takes manual methods is only one aspect of the continued success. The inclusion of near-real-time environmental data into these products means a commander has a product that reflects the present situation on the battlefield not the situation which occurred one or two days before. The third aspect of this program is the ability to generate products the commander always wanted but never had at his disposal, and the products he never even dreamed he would have at his disposal. ALBE is providing an important tool to the Army that will help soldiers fight and win on the battlefield of the future.



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